

CLAIMS

1. A device for the partial crystallisation of a phase in a solution, comprising at least one pump (1) for circulation 5 of the solution in a circuit (20) of a heat exchanger (2) formed from at least one tube (200) in contact with a cooling circuit (22), characterised in that the circuit (20) of the exchanger (2) includes a zone comprising static means to maintain supercooling in order to delay the appearance of 10 crystals, and a zone comprising static supercooling rupture means to allow the appearance of crystals.

2. A device according to the previous claim, also comprising a zone comprising static devices for mixing the 15 solution so that the crystallised particles of the phase are continuously mixed with the solution during the circulation of the said solution.

3. A device according to one of the previous claims, in 20 which the supercooling maintenance means include a non-stick coating on at least one part of the internal walls of each tube (200), where the coating takes the form of a material and/or of a surface state designed to delay the appearance of crystals.

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4. A device according to the previous claim, in which the material is a hydrophobic plastic or glass.

5. A device according to claim 3 or 4, in which the 30 surface state has a low roughness.

6. A device according to one of the previous claims, in which the supercooling rupture means include at least one

change of lining of the internal walls of each tube, and/or at least one change of direction of the circulation of the solution, and/or at least one obstacle (207, 208) to the circulation of the solution on the internal walls of each 5 tube.

7. A device according to the previous claim, in which the change of lining of the internal walls takes the form of a change of material and/or of a change of the surface state, 10 designed to interrupt the supercooling and allow the appearance of crystals.

8. A device according to the previous claim, in which the material of the supercooling rupture means is a metal.

15 9. A device according to claim 7 or 8, in which the change of surface state at the supercooling rupture means takes the form of greater roughness.

20 10. A device according to one of the previous claims, in which the mixing devices include at least one non-stick coating on at least one part of the internal walls of each tube (200), and/or at least one change of direction of the circulation of the solution, and/or at least one obstacle 25 (207, 208) to the circulation of the solution on the internal walls of each tube.

11. A device according to claim 6 or 10, in which the change of direction is an elbow (201) in the circulation 30 circuit, and/or a chicane (202), and/or at least one change of section (203) inside the circulation circuit.

12. A device according to claim 6 or 10, in which the obstacles (207, 208) to the circulation of the solution include needles and/or plates.

5 13. A device according to one of the previous claims, in which the section inside the circuit progressively increases (204).

10 14. A device according to one of the previous claims, in which the circuit of the exchanger includes at least one valve (4, 5).

15 15. A device according to the previous claim, in which the valve is placed upstream or downstream of the exchanger and is used to adjust the flow of the solution in order to control the rate of crystallisation or the ice grade.

20 16. A device according to one of the previous claims, in which the pump is designed to circulate the solution in a manner that varies with time.

17. A device according to one of the previous claims, in which the circulation circuit includes means (205, 206) for introducing bubbles of gas into the solution.

25 18. A device according to the previous claim, in which the means (205, 206) for introducing the gas are placed in the circulation of the solution or at the walls of a tube.

30 19. An assembly, characterised in that it includes a multiplicity of devices according to one of the preceding claims.

20. A method for the partial crystallisation of a phase in a solution, comprising a step that consists in circulating the solution in a circuit (20) of a heat exchanger (2) formed from at least one tube (200) using at least one pump (1),

5 characterised in that it includes a step that consists in

- holding the temperature below the start-of-freezing temperature in order to delay the appearance of crystals with static supercooling maintenance means, and

- bringing about supercooling rupture with static supercooling rupture means to trigger the appearance of the 10 crystallisation.

21. A method according to the previous claim, comprising a step consisting in continuously mixing the crystallised 15 particles of the phase with the solution during the circulation of the said solution by means of static solution mixing devices.

22. A method according to the previous claim, comprising 20 a step consisting in varying the flow of the solution over time, by acting on a valve or on the pump.

23. A method according to one of claims 20 to 22, comprising a step consisting in varying the flow of the 25 solution by means of a valve in the circulation circuit.

24. A method according to one of claims 20 to 23, comprising a step consisting in introducing bubbles of gas into the solution circulation circuit (20).